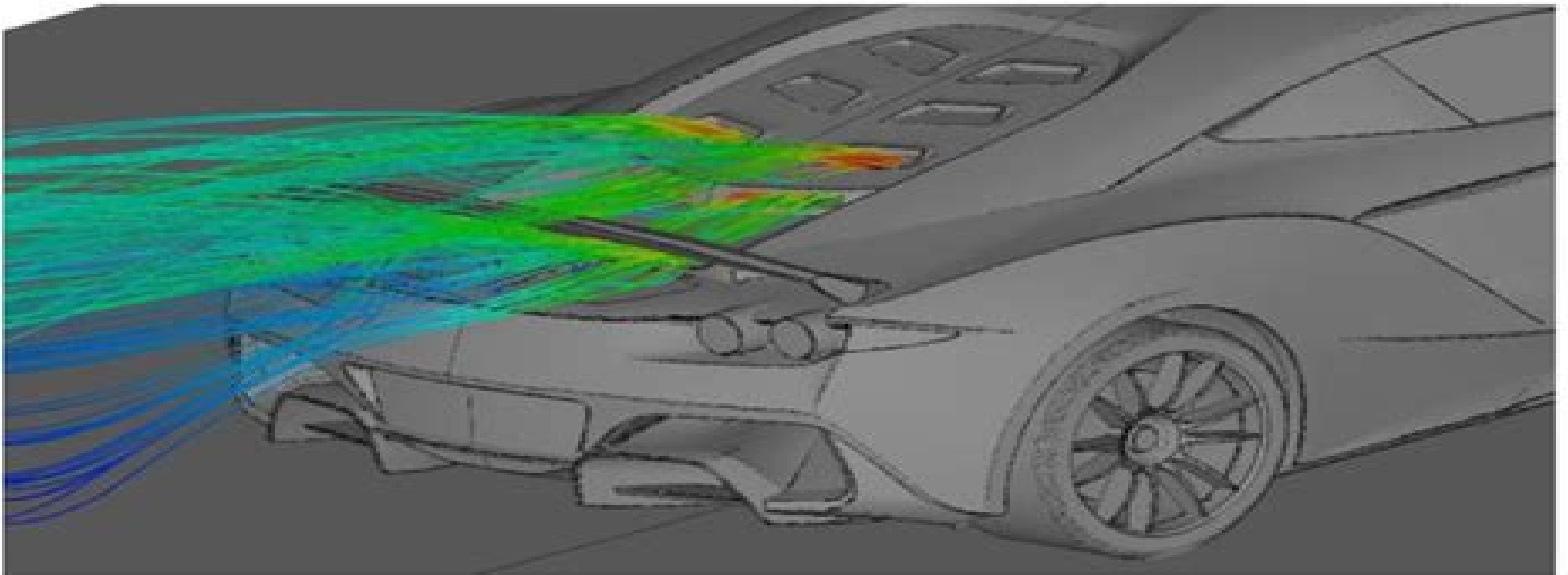
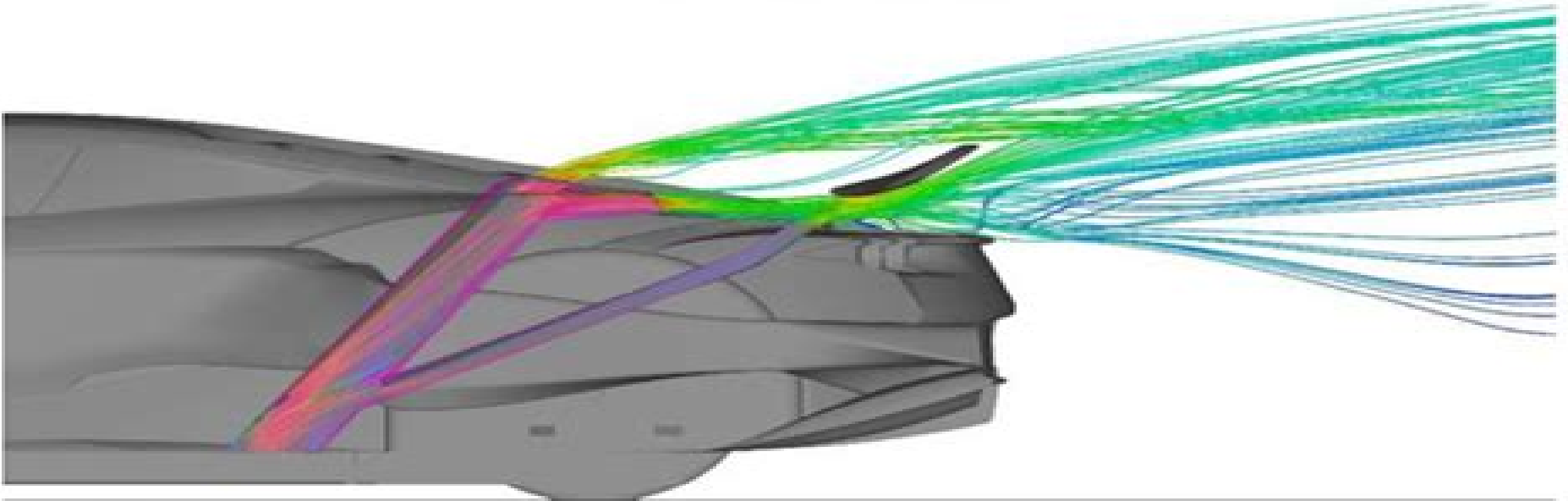


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Road Vehicle Aerodynamics

R. H. Barnard



Road Vehicle Aerodynamics:

Aerodynamics of Road Vehicles Syed R. Ahmed, 1998 For years engineers have turned to Aerodynamics of Road Vehicles as their bible on this field The fourth edition continues this tradition Much of the material has been substantially revised and new chapters on wind noise and motorcycles have been added Aerodynamics of Road Vehicles thoroughly covers the fundamental principles that influence vehicle performance handling safety and comfort An excellent introduction to the topic for the novice or student and a useful refresher and reference for the expert the book focuses on The fundamentals of fluid dynamics as related to vehicle aerodynamics Specific experimental results Design strategies showing how existing individual results can be applied to specific problems Development techniques as related to different types of wind tunnels on road tests and numerical methods The aerodynamics of passenger cars commercial vehicles sports and race cars and motorcycles are dealt with in detail Related fields that are influenced by aerodynamics are also covered including the effects of aerodynamics on fuel economy directional stability engine cooling and passenger comfort Contents include Introduction to Automobile Aerodynamics including a section on its history Some Fundamentals of Fluid Mechanics Performance of Cars and Light Trucks Aerodynamics Drag of Passenger Cars Directional Stability Function Safety and Comfort Wind Noise High Performance Vehicles Commercial Vehicles Motorcycles Engine Cooling Heating Ventilating and Air Conditioning of Passenger Cars Wind Tunnels Measurement and Test Techniques Computational Fluid Dynamics Aerodynamics of Road Vehicles is an indispensable book for vehicle engineers designers researchers and those working in government regulatory agencies It is also an excellent introduction for students and an insightful look for the enthusiast at why vehicles behave as they do The book covers aerodynamic principles of Passenger cars Commercial vehicles Sports and race car Motorcycles By reading this book vehicle engineers and designers will be able to Apply general rules to solve your own design problems Develop test techniques and design strategies to maximise aerodynamic effectiveness Car enthusiasts will gain an understanding of Why vehicles behave as they do The factors affecting vehicle performance handling safety and comfort Students will learn The fundamentals of aerodynamics and its application in the real world of vehicle design How to apply specific experimental results as general rules to solve design problems P

Aerodynamics of Road Vehicles Wolf-Heinrich Hucho, 2013-10-22 Aerodynamics of Road Vehicles details the aerodynamics of passenger cars commercial vehicles sports cars and race cars their external flow field as well as their internal flow field The book after giving an introduction to automobile aerodynamics and some fundamentals of fluid mechanics covers topics such as the performance and aerodynamics of different kinds of vehicles as well as test techniques for their aerodynamics The book also covers other concepts related to automobiles such as cooling systems and ventilations for vehicles The text is recommended for mechanical engineers and phycisists in the automobile industry who would like to understand more about aerodynamics of motor vehicles and its importance on the field of road safety and automobile production

Road Vehicle Aerodynamic Design R. H. Barnard, 1996 This text provides a comprehensive

introduction to road vehicle aerodynamic design for students engineers and designers working in the automotive field

Road Vehicle Aerodynamics A. J. Scibor-Rylski,1984 *Aerodynamics of Road Vehicles* Thomas Christian

Schuetz,2015-12-30 The detailed presentation of fundamental aerodynamics principles that influence and improve vehicle design have made *Aerodynamics of Road Vehicles* the engineer s source for information This fifth edition features updated and expanded information beyond that which was presented in previous releases Completely new content covers lateral stability safety and comfort wind noise high performance vehicles helmets engine cooling and computational fluid dynamics A proven successful engineering design approach is presented that includes Fundamentals of fluid mechanics related to vehicle aerodynamics Essential experimental results that are the ground rules of fluid mechanics Design strategies for individual experimental results General design solutions from combined experimental results The aerodynamics of passenger cars commercial vehicles motorcycles sports cars and race cars is dealt with in detail inclusive of systems testing techniques measuring and numerical aerodynamics methods and simulations that significantly contribute to vehicle development *Aerodynamics of Road Vehicles* is an excellent reference tool and an indispensable source for the industry s vehicle engineers designers and researchers as well as for enthusiasts students and those working in academia or government regulatory agencies Advanced in Road Vehicle Aerodynamics not held). International Symposium on Road Vehicle Aerodynamics

(2nd : 1973 : Projected,1973 **Road Vehicle Dynamics: Fundamentals Of Modeling And Simulation** Giancarlo Genta,Alessandro Genta,2016-12-28 *Road Vehicle Dynamics* supplies students and technicians working in industry with both the theoretical background of mechanical and automotive engineering and the know how needed to perform numerical simulations Bringing together the foundations of the discipline and its recent developments in a single text the book is structured in three parts it begins with a historical overview of road vehicles then deals with the forces exchanged between the vehicle and the road and the vehicle and the air and finally deals with the dynamic behavior of the vehicle in normal driving conditions with some extensions towards conditions encountered in high speed racing Coverage of contemporary automatic controls is included in this edition **Modifying the Aerodynamics of Your Road Car** Julian Edgar,Richard H.

Barnard,2019-01-08 *Modifying the Aerodynamics of Your Road Car* is a unique handbook that assumes no starting knowledge of vehicle aerodynamics It begins with simple ideas and finishes with sophisticated and effective aerodynamic modifications that work Three major chapters cover on road testing techniques that give you all the information you need to decide what modifications you should make and after you ve made them how well they work Low cost techniques allow you to visualize the patterns of airflow over your car so that you can actually see the problem areas that need improvement Uniquely you re also shown how to measure aerodynamic pressures so you can determine which body surfaces are creating lift drag and downforce Want to work out where a wing should be placed On road testing to find that out is covered as well The book also shows you how to measure downforce to see if that wing is actually working If you wish to reduce drag more than ten

different areas are covered Reducing frontal area lowering cooling system drag optimizing vehicle ride height and rake reducing the strength of the wake achieving clean airflow separation and optimizing wheel designs are all covered using the latest research findings And if you re a performance driver there s a major chapter devoted to reducing lift and improving stability This chapter includes the design and development of undertrays and diffusers wings and spoilers The example car developed measurable downforce when fitted with an undertray and rear diffuser something that transformed its on road handling The author has been writing about the aerodynamics of road cars for more than 25 years He is also an experienced and proficient car modifier who has performed numerous aerodynamic modifications and upgrades to his own cars The book s technical consultant RH Barnard is an acknowledged world leading automotive aerodynamicist If you want a practical hands on guide that demystifies and explains car aerodynamics and shows you how to make effective aerodynamic modifications to your car this book is for you

Aerodynamic Testing of Road Vehicles - Testing Methods and Procedures Road Vehicle Aerodynamics Forum Committee,2016 The scope of this SAE Information Report is confined to wind tunnel testing although it is recognized that many aspects of the aerodynamic characteristics of road vehicles can be investigated in other test facilities such as water tanks or especially on the road For example coastdown testing is often used to determine aerodynamic drag either in isolation or as part of the total resistance and artificial gust generators are used to investigate the sensitivity of vehicles to cross wind gusts Also excluded from the present Report are climatic wind tunnel tests of road vehicles which are defined in more detail in Section 3 The Report covers the aerodynamic requirements of a wind tunnel for automotive testing together with the facility equipment needed and the requirements affecting the test vehicle or model The test methods and procedures described here include those for six component force measurements and measurements of pressures and velocities both on the vehicle model surface and in the surrounding flow field Flow visualization techniques are outlined with reference to the detailed coverage in a related SAE Information Report 2 In addition the reduction analysis and presentation of wind tunnel data are considered with further references to associated SAE Information Reports 3 4 on corrections to be applied for wind tunnel blockage effects Finally methods are discussed for the validation of the wind tunnel data e g by tunnel to road correlation studies As already indicated this document has been prepared in conjunction with a number of other SAE Information Reports and Recommended Practices 1 5 each of which provides greater detail than is given here on its particular aspect of automotive aerodynamic testing Much of the information presented in this document is mature and unlikely to change in the foreseeable future The remainder relating particularly to moving ground simulation and blockage correction techniques is nevertheless judged by the Road Vehicle Aerodynamics Committee to be of historical significance To supplement its contents users are encouraged to consult more recent revisions of J1252 J1594 and J2881 as well as relevant SAE conference papers published since the 1993 issue of this document

Aerodynamic Drag Mechanisms of Bluff Bodies and Road Vehicles Gino Sovran,2012-12-06 These Proceedings

contain the papers and oral discussions presented at the Symposium on AERODYNAMIC DRAG MECHANISMS of Bluff Bodies and Road Vehicles held at the General Motors Research Laboratories in Warren Michigan on September 27 and 28 1976 This international invitational Symposium was the twentieth in an annual series each one having been in a different technical discipline The Symposia provide a forum for areas of science and technology that are of timely interest to the Research Laboratories as well as the technical community at large and in which personnel of the Laboratories are actively involved The Symposia furnish an opportunity for the exchange of ideas and current knowledge between participating research specialists from educational industrial and governmental institutions and serve to stimulate future research activity The present world wide energy situation makes it highly desirable to reduce the force required to move road vehicles through the atmosphere A significant amount of the total energy consumed for transportation is expended in overcoming the aerodynamic resistance to motion of these vehicles Reductions in this aerodynamic drag can therefore have a large impact on ground transportation energy requirements Although aerodynamic development work on road vehicles has been performed for many years it has not been widely reported or accompanied by much basic research

Vehicle Aerodynamics

Terminology Road Vehicle Aerodynamics Forum Committee, 2010 This terminology is intended to provide a common nomenclature for use in publishing road vehicle aerodynamics data and reports This document has been revised to correct numerous errors and omissions in the previous 1994 revision That revision whose sole purpose was to place it into the new SAE Technical Standards Board format was the only revision to the original 1987 issue The current 2010 revision has also been used as an opportunity to update applicable references delete those that are no longer readily available improve the organization of the document and modify the directional sense of the axes system as indicated below The following is the rationale for selection of specific terminologies conventions and definitions

Axes System The SAE Road Vehicle Aerodynamics Committee agreed to modify the axes system in the original SAE J1594 issued in 1987 to have x positive rearward and z positive upward to correspond with the positive directions of drag and lift respectively This change does not affect the positive sense of the aerodynamic forces and moments as defined in the previous version of SAE J1594 only their directional sense specifically for drag lift yawing moment and rolling moment relative to the signs of the x and z axes in the new axes system

Resolving Center Center of gravity c_g and body geometry defined resolving centers used in vehicle dynamics

Reference 2 1 1 and aeronautics respectively are not satisfactory for road vehicle aerodynamics applications A large portion of automotive aerodynamics development testing is performed before the vehicle c_g is known The c_g location can also vary significantly with vehicle option content and loading Relating the axis center to the body geometry is also problematic when major body geometry changes are explored during wind tunnel tests These situations are avoided by placing the resolving center at ground level positioned at mid wheelbase and mid track An added advantage of this location is the direct translation of aerodynamic loading to tire contact patch ground reactions

Forces and Moments The primary

terminology for aerodynamic force and moment components drag lift side force pitching moment yawing moment and rolling moment were adopted from aeronautical usage The symbols for drag and lift D L were also taken from aeronautics To maintain consistency with the symbols for drag and lift and to provide a mnemonic aid the other component symbols S P M Y and R were based on terminology Attitude Angles Vehicle attitude angle definitions and symbols also correspond to existing aerodynamics terminology as used for aircraft development Force and Moment Coefficients Aerodynamic coefficient definitions were chosen consistent with aeronautical terminology with one exception Unlike typical aerodynamics convention the wheelbase is used to compute moment coefficients Although it makes more aerodynamic sense to use a body length dimension this is more likely to change during wind tunnel development than wheelbase Using wheelbase WB provides an additional advantage with the chosen axes system in simplifying the computation of axle loadings For example the lift coefficient for the front axle is then equal to CL_F / CL_2 CPM However if CPM were based on an overall length OAL a ratio of WB and OAL would have to be included in the computation Vehicle Parameters The wheelbase designator L used in vehicle dynamics Reference 2 1 1 1 was not adopted since it is used for the aerodynamic lift force Frontal area and scale factor symbols are consistent with aerodynamic usage Flow Parameters Symbols and definitions for air flow parameters were chosen consistent with aerodynamics terminology The definition of equivalent full scale velocity VEQ is included to provide a simple means of relating reduced scale model flow conditions to full scale Standard day conditions were chosen to correspond to those defined at sea level conditions for the U S Standard Atmosphere adopted by NASA NOAA and USAF in 1976 Reference 2 1 3 1 For high speed motorsports and high humidity thermal applications references are cited to account for the effects of compressibility on dynamic pressure and relative humidity on air density if deemed necessary Yaw Weighted Drag Coefficient Ambient wind magnitude heading angle and vehicle path directions have an effect on the overall average aerodynamic drag of a vehicle during a particular duty cycle The yaw weighted drag coefficient is defined as the average drag coefficient during a particular driving schedule and ambient wind input The wind and driving schedule factors affecting the wind averaged drag coefficient have not been standardized Some examples of yaw weighted drag coefficient

computations are given in References 2 1 1 2 2 1 1 4 **Advances in Road Vehicle Aerodynamics** H.S. Stephens,1973

Advances in Road Vehicle Aerodynamics 1973 Herbert Simon Stephens,1973 **Fundamental Investigation of Road Vehicle Aerodynamics** Abdullah M. Al-Garni,2003 **Aerodynamics of Road Vehicles** Wolf-Heinrich Hucho,1993

Modifying the Aerodynamics of Your Road Car Julian Edgar,2018 Want to improve handling straight line performance or fuel economy In that case you ll achieve best results by modifying your vehicle s aerodynamics This handbook is a must read that takes you from testing the standard car through to making sophisticated aerodynamic modifications that have real impact **Road Vehicle Aerodynamics** London. The City University. Department of Aeronautics,1970

Theory and Applications of Aerodynamics for Ground Vehicles T Yomi Obidi,2014-03-20 This book provides an

introduction to ground vehicle aerodynamics and methodically guides the reader through the various aspects of the subject. Those needing specific information or a refresher can easily jump to the material of interest. There is a particular emphasis on various vehicle types: passenger cars, trucks, trains, motorcycles, race cars, etc. However, the book is focused on cars and trucks, which are the most common vehicles in the speed range in which the study of ground vehicle aerodynamics is beneficial. Readers will gain a fundamental understanding of the topic, which will help them design vehicles that have improved aerodynamics; this will lead to better fuel efficiency, improved performance, and increased passenger comfort. The author's basic approach to the presentation of the material is complemented with review questions, application questions, exercises, and suggested projects at the end of most of the chapters, which helps the reader apply the information presented either in the classroom or for self study. Aside from offering a solid understanding of ground vehicle aerodynamics, the book also offers more thorough study of several key topics. One such topic is car-truck interaction when one vehicle, usually the smaller one, is overtaking the other. There is a direct and instant benefit in terms of safety on the highway from understanding the forces at play when one vehicle passes the other in the same direction and sense. Chapters examine Drag, Noise, and vehicle soiling; Wind tunnels and road track testing; Numerical methods; Vehicle stability and control; Vehicle sectional design; Large vehicles: trucks, trailers, buses, trains; Severe service and off-road vehicles; Race cars and convertibles; Motorcycles; Concept vehicles.

Measurement of Aerodynamic Performance for Mass-Produced Cars and Light-Duty Trucks

Road Vehicle Aerodynamics Forum Committee, 2019. This Recommended Practice provides a procedure for measuring and documenting the aerodynamic performance in a full-scale wind tunnel of passenger vehicles, i.e., mass-produced cars and light-duty trucks intended primarily for individual consumers. Testing or numerical modeling of pre-production and/or reduced-scale models is outside the scope of this document. Aerodynamic development procedures, i.e., methods to improve or optimize aerodynamic performance, are also excluded. It is well known that aerodynamic performance results depend significantly on vehicle content and loading, as well as the wind tunnel itself, type, scale, and simulation qualities of the wind tunnel. Publication of non-standard test results causes unnecessary additional development work and incorrect perception of a vehicle's anticipated aerodynamic performance by government, academia, and the general public. The intent of this document is to promote uniformity and traceability of published aerodynamic performance data acquired in a wind tunnel, thereby enhancing the public reputation and credibility of the aerodynamics discipline in the total vehicle development process. Measurement of the aerodynamic performance according to this Recommended Practice requires a full-scale wind tunnel test on a production-ready full-scale vehicle according to specifications for vehicle loading, content, and wind tunnel conditions. The measurement and resulting documentation for a particular vehicle shall be reported only by the company that intends to produce the vehicle. Whenever there is an opportunity for interpretation of the document, a good faith effort shall be made to obtain the vehicle's typical in-service performance and avoid finding the best possible performance under the best possible

circumstances Use of and compliance with this Recommended Practice is voluntary however it is mandatory for those advertising or otherwise publishing aerodynamic performance as measured according to SAE J2881 Conversely any advertised or otherwise published result carrying this or a substantially similar designation must have the necessary documentation accepted by and on file with the SAE in accordance with the procedures defined in this Recommended Practice Appendices B and C contain the necessary submittal documents for compliance with this Recommended Practice When a submittal is made the chairman of the Road Vehicle Aerodynamics Forum Committee RVAC or his her designee shall review the submittal for proper completion according to the requirements herein but without consideration of the technical merit of the claimed performance After the chairman s review SAE will maintain an electronic database of all submittals The database shall be available only to members and liasion members of the RVAC Any RVAC member who retrieves information from the database shall do so with the understanding that the information is to be considered confidential within his or her company This Recommended Practice defines the method for documenting road vehicle aerodynamic performance along with the associated vehicle set up and full scale wind tunnel conditions employed for the measurement This is one of the key elements of achieving an overall aerodynamic certification standard for passenger vehicles Road Vehicle Aerodynamics. Second Edition A. J. Scibor-Rylski,D. M. Sykes,1984

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